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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/657,505	09/08/2003	Chii-Ming Wu	TS01-1247	9336
42717	7590	04/03/2006	EXAMINER	
HAYNES AND BOONE, LLP 901 MAIN STREET, SUITE 3100 DALLAS, TX 75202			GEYER, SCOTT B	
			ART UNIT	PAPER NUMBER
			2812	

DATE MAILED: 04/03/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/657,505

Applicant(s)

WU ET AL.

Examiner

Scott Geyer

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 26 January 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-15 and 17-51 is/are pending in the application.
- 4a) Of the above claim(s) 4, 17 and 25-51 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-3, 5, 7-15, 18 and 20-24 is/are rejected.
- 7) ☒ Claim(s) 6 and 19 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 08 September 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Applicant notes:

-The examiner of record has changed since the previous office action.

-Claims 1-15 and 17-51 are pending in the application. Claims 26-51 are currently withdrawn as being drawn to non-elected invention. Claims 4, 17 and 25 are also withdrawn but will be re-joined and allowed upon the establishment of independent claims 1 or 12 being found allowable.

-The following rejection is non-final, due to the citation of new prior art references. In response to this action, the applicant is invited to cancel claims 26-51, since they are drawn to non-elected species.

Drawings

The drawings submitted on September 8, 2003 are acceptable.

Claim Objections

The objection to claim 5 is withdrawn in view of applicant's amendment to the claim.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

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A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1 and 10 are rejected under 35 U.S.C. 102(b) as being anticipated by Gates et al. (6,203,613 B1).

As to **claim 1**, Gates et al. teach an ALD process to deposit a metal nitride layer on a substrate (see column 2, line 59 et seq.). ALD, as described by Gates et al., is a process of loading a substrate in a chamber, and alternating pulses of precursor, reactant and purge gases, which covers applicant's steps (a) through (g). As identified in example 6 of Gates et al. (in column 10), a nitrogen containing reactant is introduced, the chamber is purged and then a metal precursor is introduced. The process is repeated to achieve a desired thickness.

As to **claim 10**, Gates et al. teaches any desired thickness may be obtained by adjusting the number of gas switching cycles (see column 11, lines 3-4).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 2, 5, 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (6,203,613 B1).

As to **claim 2**: Gates et al. teach a chamber temperature of 500°C but do not teach a pressure of 0.1-50 Torr. As to **claim 5**: Gates et al. teach a pulse rate of 0.1-5 seconds of the metal precursor flowed into the chamber, but do not teach a flow rate of 500-10000 sccm. As to **claim 7**: Gates et al. teach inert gases such as argon, helium and nitrogen pulsed between 0.1-5 seconds, but do not teach a flow rate of 500-10000 sccm. As to **claim 8**: Gates et al. teach ammonia as the nitrogen reactant pulsed between 0.1-5 seconds, but do not teach a flow rate of 500-10000 sccm. The examiner notes that applicant does not teach that the flow rates and pressure as claimed solve any stated problem or are for any particular purpose. Therefore, the flow rates and pressure lack criticality in the claimed invention and therefore do not produce unexpected or novel results. It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the cited pressure and flow rates because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ 2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ 2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable

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in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

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Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (6,203,613 B1) as applied to claim 1 above, and further in view of Cao et al. (6,972,267 B2).

As to **claim 3**, Gates et al. teach an ALD process as noted above for claim 1, but do not teach the specific metal precursor as noted in claim 3. However, Cao et al. teach a similar ALD process for producing metal nitride wherein the metal precursor is TBTDET (an organo-metal precursor) (see abstract). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Gates et al. with TBTDET as the metal precursor as taught by Cao et al. since TBTDET (being an organo-metallic precursor gas) has a lower deposition temperature compared to metal-halide precursors.

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Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (6,203,613 B1) as applied to claim 8 above, and further in view of Meng et al. (6,967,154 B2).

As to **claim 9**, Gates et al. teach a nitrogen reactant and a metal precursor reacting to form a metal nitride, as noted above for claims 1 and 8. Gates et al. do not teach a plasma to assist in the reaction between the two. However, Meng et al. teach an ALD process to deposit a metal nitride wherein plasma is used to assist the

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deposition (see abstract). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Gates et al. with a plasma assist as taught by Meng et al. to assist in dissociating the gas materials to enhance the reaction and deposition process.

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Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (6,203,613 B1) in view of Cao et al. (6,972,267 B2).

As to **claim 11**, Gates et al. is cited (as noted above for claim 1) for teaching an ALD process. Gates et al. also teach flowing a metal precursor into the chamber first, purging, and then flowing the nitrogen containing reactant into the chamber, as noted in column 10, example 5. Gates et al. do not teach the specific metal precursors noted in applicant's claim 11. However, Cao et al. teach a similar ALD process for producing metal nitride wherein the metal precursor is TBTDET(an organo-metal precursor) (see abstract). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Gates et al. with TBTDET as the metal precursor as taught by Cao et al. since TBTDET (being an organo-metallic precursor gas) has a lower deposition temperature compared to metal-halide precursors.

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Claims 12-15, 18, 20, 21 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (6,203,613 B1) in view of Cao et al. (6,972,267 B2) and Choi et al. (6,815,285 B2).

As to **claim 12**, Gates et al. is cited (as noted above for claim 1) for teaching an ALD process. Gates et al. also teach flowing a metal precursor into the chamber first, purging, and then flowing the nitrogen containing reactant into the chamber, as noted in column 10, example 5. Gates et al. do not teach the specific metal precursors noted in applicant's claim 12 nor do Gates et al. teach planarization of the metal nitride layer. However, Cao et al. teach a similar ALD process for producing metal nitride wherein the metal precursor is TBTDET(an organo-metal precursor) (see abstract). Choi et al. also teach a metal nitride deposition process utilizing ALD, wherein the metal nitride is planarized (see figures 10 and 11). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Gates et al. with TBTDET as the metal precursor as taught by Cao et al. and planarization as taught by Choi et al., since TBTDET (being an organo-metallic precursor gas) has a lower deposition temperature compared to metal-halide precursors and planarization allows for removal of unwanted material.

As to **claim 14**, Gates et al. teach a via with a diameter of 100 nm (see column 5, lines 22-23).

As to **claim 13**: Gates et al. teach a dielectric material, but do not teach the material being low-k or having a thickness of 1000-10000 angstroms. As to **claim 15**: Gates et al. teach a chamber temperature of 500°C but do not teach a pressure of 0.1-

50 Torr. As to **claim 18**: Gates et al. teach a pulse rate of 0.1-5 seconds of the metal precursor flowed into the chamber, but do not teach a flow rate of 500-10000 sccm. As to **claim 20**: Gates et al. teach inert gases such as argon, helium and nitrogen pulsed between 0.1-5 seconds, but do not teach a flow rate of 500-10000 sccm. As to **claim 21**: Gates et al. teach ammonia as the nitrogen reactant pulsed between 0.1-5 seconds, but do not teach a flow rate of 500-10000 sccm. The examiner notes that applicant does not teach that the flow rates, pressure, low-k or thickness as claimed solve any stated problem or are for any particular purpose. Therefore, the flow rates, pressure, low-k and thickness lack criticality in the claimed invention and therefore do not produce unexpected or novel results. (Further, the applicant does not provide any definition as to what dielectric constant is associated with 'low-k'). It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the cited pressure and flow rates because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ 2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ 2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105

USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

As to **claim 23**, Cao et al. teach measuring the thickness of the metal nitride layer (see figure 8, step 116 and see also column 7, line 15 et seq.).

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Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (6,203,613 B1), Cao et al. (6,972,267 B2) and Choi et al. (6,815,285 B2) as applied to claim 21 above, and further in view of Meng et al. (6,967,154 B2).

As to **claim 22**, Gates et al. teach a nitrogen reactant and a metal precursor reacting to form a metal nitride, as noted above for claims 12 and 21. Gates et al. do not teach a plasma to assist in the reaction between the two. However, Meng et al. teach an ALD process to deposit a metal nitride wherein plasma is used to assist the deposition (see abstract). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Gates et al. with a plasma assist as taught by Meng et al. to assist in dissociating the gas materials to enhance the reaction and deposition process.

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Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. (6,203,613 B1), Cao et al. (6,972,267 B2) and Choi et al. (6,815,285 B2) as applied to claim 12 above, and further in view of examiner's official notice.

As to **claim 24**, Choi et al. teach planarization of the metal nitride, although Choi et al. does not teach chemical mechanical polishing (CMP) to achieve the planarization.

However, it is notoriously well known in the art of semiconductor manufacturing to use CMP to achieve a planar surface, and it would have been obvious to a person of ordinary skill in the art to use CMP to achieve a planar surface and to remove unwanted excess material.

Allowable Subject Matter

Claims 6 and 22 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Response to Arguments

Applicant's arguments with respect to claims 1-3, 5-15 and 18-24 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Scott Geyer whose telephone number is (571) 272-1958. The examiner can normally be reached on weekdays, between 10:00am - 6:30pm. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from

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the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR.

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For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should

you have questions on access to the Private PAIR system, contact the Electronic

Business Center (EBC) at 866-217-9197 (toll-free).

SBG
March 30, 2006

SCOTT B. GEYER
PRIMARY EXAMINER



3/30/06